



Bayesian networks -an example of software and some defence applications

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Abstract

We review publicly available information and software on Bayesian networks from the point of view of military applications. A brief introduction to Bayesian networks and influence diagrams is given as well as potential military applications for them. Existing free Bayesian network software is reviewed and compared and it was found out that GeNie was the most appropriate one for military defence applications. Alongside the features, observed weaknesses and common pitfalls in use are reported. In addition to this, time requirements of network inference are explored, and the available algorithms in our selected software are compared.

Introduction -complexity of a military scenario

Bayesian networks are used in the science and industry e.g. to cope the complexity of a system of systems. We found that Bayesian networks are used also to handle the complexity of warfare.

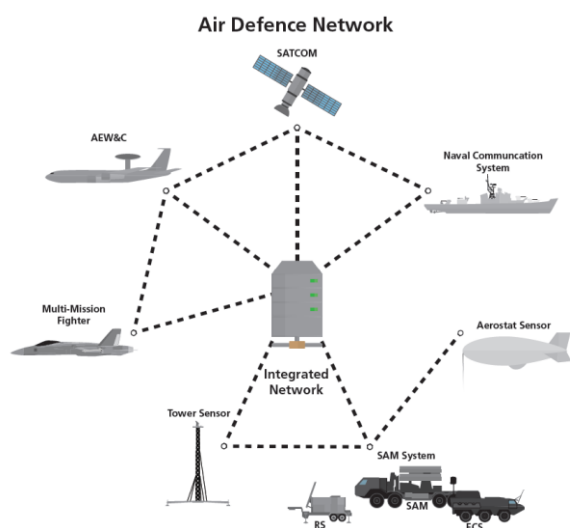


Figure 1. An illustration of the complexity of an air defence network.

Influence diagrams

Influence diagrams are a generalization of Bayesian networks used in decision analysis. In an influence diagram, the parts of the model representing the decisions of a given party are not random. The general goal of the model is to find an optimal decision policy for the party in question. In addition to this, the support for decision analysis provided by influence diagrams is a major advantage.

Software comparison

We estimated the most valuable features of the programs to be as following. Since defence is highly interdisciplinary, the quality of graphical presentation and its clarity is a significant factor in software, as well as the support influence diagrams. A major strength of Bayesian networks is their graphical presentation. Precisely due to the clarity of this presentation, one can obtain a surface level understanding of Bayesian network -based models without much education in statistics. selection. By those measures we found GeNie to be the most appropriate.

Example of situation assesment

If one considers how information assesment is conducted, one obtains a structure well suitable for Bayesian networks.

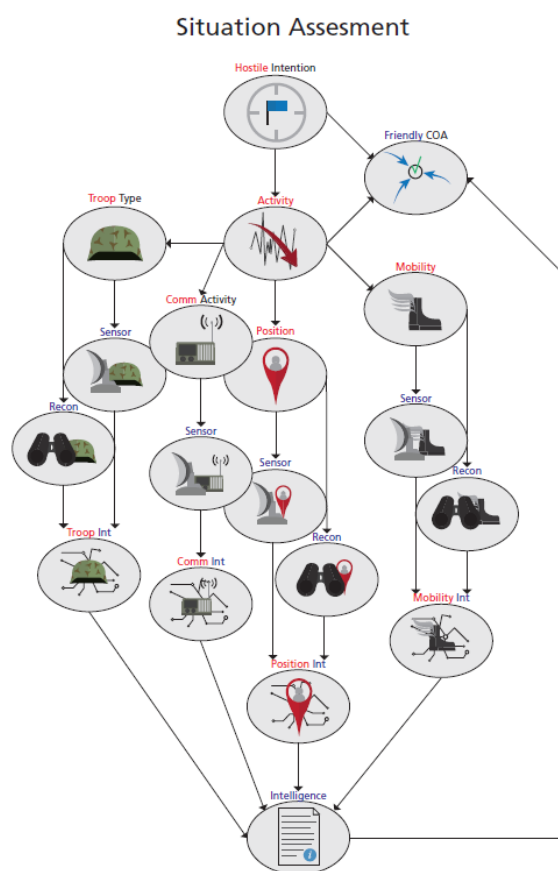


Figure 2. The principle of how situation assesment might be conducted.

Conclusions

Bayesian networks and influence diagrams were reviewed from the point of view of defence applications. Various applications of Bayesian networks and influence diagrams in military related fields were enumerated. Existing free software for Bayesian network and influence diagram inference was compared. It was determined that from a defence point of view, a combination of graphical representation features and programming interfaces is recommended. The most effective combination of these two was found in GeNie and SMILE. An examination of the features of GeNie and SMILE was performed. Within this examination, capabilities of the two programs were reported, as were encountered issues and deficiencies. In addition to this, inference complexity and the available algorithms of GeNie and SMILE were investigated. The investigation concluded with the exact algorithms being preferable for most influence diagrams, with approximate algorithms being of use only for models with a large and highly complicated chance node structure.

